Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

A SPECIAL FIELD OF USEFULNESS FOR SMALL TELESCOPES IN PHOTOGRAPHING STELLAR SPECTRA

By Paul W. Merrill

The idea that it is hopeless or unwise to attempt any problem of investigational astronomy with a small or moderate-sized telescope is certainly ill founded. Large instruments have not and will not destroy extensive fields of usefulness for small instruments. The professional or amateur astronomer with a telescope having an aperture of four inches or more, has plenty of attractive opportunities for useful investigation, in addition to the joys of general observation. For example, he may do photometric work on variable stars, or photograph stellar spectra with an objective prism, or make interesting and valuable experiments bearing on new applications of the Michelson interference methods.

In stellar spectroscopy there is a special field of usefulness for small telescopes which has never been fully exploited and which it is the purpose of this article to describe.

The spectra of stars can be efficiently photographed with small telescopes by placing a prism (say of 15° angle) over the object glass. The image of each star in the focal plane will then be a spectrum instead of a point. The spectrum can be kept narrow, or can be widened by placing the edge of the prism parallel to the celestial equator and allowing the exposure to proceed while the telescope is moved by its driving clock at a rate slightly different from that at which the telescope exactly "follows" the star. It would take too much space even to mention the results already achieved by the application of this method, since a large part of our knowledge of the spectra of the stars has been derived in this manner. It happens, however, that nearly all of this very extensive observational material refers only to those portions of the spectrum to which an ordinary photographic plate is sensitive, namely, the blue, violet, and ultra-violet. The lack of observations in the green and yellow and especially in the red is doubtless due principally to the fact that until recently photographic emulsions which were sufficiently sensitive in these regions have not been available. Hence the strong hydrogen line Hα, in the red (wave-length 6563 angstroms) has not been commonly observed in stellar spectra in spite of its great importance in several classes of stars. This line is bright in numerous stellar spectra and in frequent instances is so intense and conspicuous as to be readily shown on photographs having very small dispersion. Moreover, when bright it is subject to change so that stars showing this feature should be photographed at frequent intervals in order that the variations may become a matter of permanent record. At present but little is known in regard to the variations, tho they are apparently of not infrequent occurrence. This spectral line, therefore, appears to be an especially suitable object for investigation with small telescopes.

The photography of the bright Hα in the spectra of numerous stars should present no difficulty with a six or even with a four-inch telescope, if an objective prism of 10° to 30° angle of sufficient size to cover the objective can be secured. The prism should be mounted rigidly in front of the objective with its edge parallel to the celestial equator, in the position of minimum deviation. The only additional adaptation of the telescope required will be an arrangement at the eye end to receive the plate holder.

Unless the observer desires to prepare his own red sensitive plates by staining ordinary emulsions with pinacyanol[1], the Ilford Special Rapid Panchromatic plates are recommended. These plates may be made several times more sensitive by the following process:

At a temperature of about 68° F., soak the plates for four minutes in

Water	75 cc.
Ethyl alcohol	25 cc.
Ammonia	4 cc.

then dry rapidly with an electric fan. If kept cool and dry these plates will remain in good condition for several weeks; under ordinary conditions they will keep for several days or a week. Good results can probably be obtained with an ammoniating bath with the alcohol omitted, especially if the air is warm and dry.

For the photography of the portion of the spectrum containing the red line of hydrogen the ordinary visual objective will, of course, be better than the so-called photographic objective which is corrected for the blue and violet rays. Good results, however, have been obtained by Mr. Humason and the writer in photographing the Hα line with a 10-inch photographic telescope. On another page in this number of the PUBLICATIONS is a list of stars in which we have discovered a bright Hα line. Figures 2, 3, 4 and 5 show the appearance of some of the spectra photographed with this instrument. The steep color curve allows only a very small section in the red to be in good focus. We have tried to make the focal setting so that Hα will occupy the center of this region. The yellow, green, and blue are badly out of focus, but in the ultra-violet the focus again becomes good so that lines near the head of the hydrogen series are well shown. It is interesting that these ultra-violet hydrogen lines are absorption lines while Hα, in the same series, is an emission line. With a visual telescope Hα and Hβ (in the blue green) can be photographed in good focus at the same time. With a reflector, especially interesting spectrograms can be obtained, as the whole spectrum will be in focus. Figure 1 is made from a plate obtained with a reflector.

---

[1] For laboratory methods of preparing red sensitive plates, consult *Circular of the U. S. Bureau of Standards*, "Color Sensitive Photographic plates," Nov. 16, 1919.

Some of the brighter stars of Class B which have bright hydrogen lines are listed below:

	R. A. 1900	Dec. 1900	Mag.
γ Cassiop	$0^h50^m.7$	+60°11′	2.2
φ Persei	1 37 .4	+50 11	4.2
ψ Persei	3 29 .4	+47 51	4.3
Alcyone	3 41 .5	+23 48	3.0
c Persei	4 1 .4	+47 27	4.0
ζ Tauri	5 31 .7	+21 5	3.0
α Columbae	5 36 .0	−34 8	2.8
κ Can. Maj	6 46 .1	−32 23	3.8
κ Draconis	12 29 .2	+70 20	3.9
η Centauri	14 29 .2	−41 43	2.6
χ Ophiuchi	16 21 .2	−18 14	4.8
P Cygni	20 14 .1	+37 43	4.9
π Aquarii	22 20 .2	+ 0 52	4.6
β Piscium	22 58 .8	+ 3 17	4.6

A valuable program would be to photograph the Hα line in the above stars at intervals of one or two months. This procedure should in time lead to the detection of any changes which may occur, whether progressive or recurring. If no difficulty is found in photographing the Hα line in these stars, the observations may be extended to fainter stars with a bright Hα. Exposures may be made on moonlight nights without the fogging usually caused by the skylight, by placing a red color filter in front of the plate. The Eastman A and F gelatine filters have been found satisfactory for this purpose.

Another interesting investigation would be the classification of M-type stars according to the intensities of bands in the extreme red, at wave-lengths approximately 7060 and 7600 angstroms. This would require the use of plates sensitized with dicyanin[2].

---

[2] *Scientific Papers of the Bureau of Standards*, No. 318, "Application of Dicyanin to the Photography of Stellar Spectra." April 6, 1918.

Fig. 1

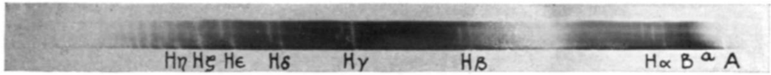


Fig. 2

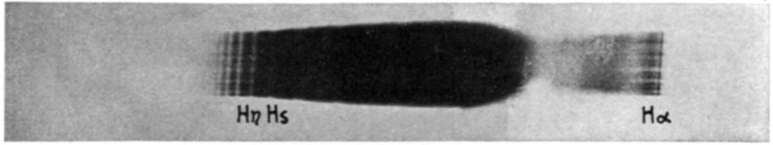


Fig. 3

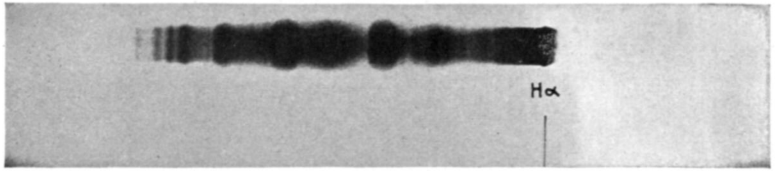
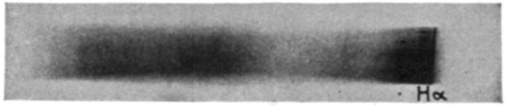


Fig. 4



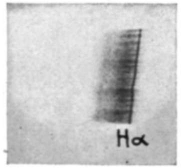


Fig. 5

PLATE X

Descriptions of Illustrations

Figure 1. *α Canis Majoris* (*Sirius*), R. A. $6^h 40^m.7$ Dec. $-16°34'$, magnitude -1.6, 1917 Feb. 16.

With 15° objective prism of 9 x 11 inches aperture on the two-foot reflector of the Harvard College Observatory. Emulsion, Seed 27 sensitized with dicyanin A.

Figures 2, 3, 4, 5. With 15° objective prism on the 10-inch Cooke telescope of the Mount Wilson Observatory.

Figure 2. *β Piscium,* R. A. $22^h\ 58^m.8$ Dec. $+3°17'$, magnitude 4.6. 1919 Aug. 4. Exposure 46 minutes. Emulsion, Seed 23 sensitized with pinacyanol. The Hα line is bright, while the ultraviolet hydrogen lines are dark.

Figure 3. *Nova Cygni,* R. A. $19^h 55^m.8$, Dec. $+53°21'$, magnitude 3.7. 1920 Aug. 30. Exposure 15 minutes. Emulsion, Ilford Special Rapid Panchromatic hyper-sensitized with ammonia. The narrow vertical line is the image of the bright Hα line formed by allowing the spectrum to drift rapidly across the plate. Negative by Mr. Humason.

Figure 4. H D 19243, R. A. $3^h 0^m.7$, Dec. $+63°7'$, magnitude 6.5. 1920 Sept. 10. Exposure 110 minutes. Emulsion, Ilford Special Rapid Panchromatic hyper-sensitized with ammonia.

Figure 5. H D 20336, R. A. $3^h 11^m.2$, Dec. $+65°17'$, magnitude 4.9. 1920 Oct. 25. Exposure 130 minutes. Emulsion, Seed 23 sensitized with pinacynol. Negative by Mr. Humason.

The coordinates given above are for 1900.0.